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(54) ELECTRO-ANAESTHESIA APPARATUS

(71) We, MOSKOVSKY OBLASTNOI NAUCHNO - ISSLEDOVATELSKY INSTITUT AKUSHERSTVA I GINEKOLOGII — a Russian corporate body Lepekhinsky tupik, 3. Pokrovskie Vorota, Moscow, USSR., do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates to medical equipment and, more particularly, to electro-anaesthesia apparatus for producing electric current pulses action upon the central nervous system, which apparatus may be used to replace psychotherapeutic medicines, tranquilizers, and general anesthetics.

Recent experimental and clinical studies have shown that the attainment of the second level of the first stage of general electro-anesthesia provides optimum conditions for self-regulation of the cerebrum with subsequent regulation of vital functions of the human organism.

The experience accumulated by today's medicine makes it possible to use the apparatus of this invention to achieve, in cinical conditions, the second level of the first stage of general electro-anesthesia for the prevention and treatment of light and moderate nephropathy, for the prevention of severe nephropathy and uterine action disorders in the course of delivery, and, finally, for raising the pain threshold in the course of preparing expectant mothers for childbirth.

With the start of regular birth-throes, the second level of the first stage of general anesthesia is employed to give a parturient a respite and replace pharmaceuticals used in cases of uterine inertia.

After alleviating the uterine inertia by attaining the second level of the first stage of general electroanesthesia, the application of current pulses is repeated to intensify uterine activity. The second level of the first stage of general electro-anesthesia may be employed in childbirth to anesthetize labor pains through intermittent analgesia. In operative gynecology, the second level of the first stage of general electro-anesthesia is employed to relieve the emotional stress in the course of preparing a patient for an operation, and as an intensified therapy means during the postpartum period.

The proposed apparatus may also be employed for electric sleep treatment and for electrotonising the uterus.

The information obtained at present as to the clinical effectiveness of the second level of the first stage of general electro-anesthesia does not exclude the possibility of employing the proposed apparatus in those fields of gynecological medicine where there is the necessity to replace pharmaceuticals by physical means to regulate the functional state of the central nervous system.

Electro-anesthesia apparatus for applying electric current pulses so as to act upon the control nervous system is known. In this known apparatus, which is used for sleep therapy, current pulses are applied to a patient via electrodes, i.e. a cathode and an anode that are attached to the patient's head. Said current pulses are applied from a unit for rhythmic current pulse action upon the central nervous system via a unit for regulating the amplitude of said current pulses, and a unit for indicating the mean value of current intensity, respectively. The sending of the pulses is stopped by a patient protection unit when the current pulse action level is in excess of a preselected value.

The foregoing apparatus acts upon the central nervous system of a patient by square current pulses through electrodes (an anode and a cathode) attached to the patient's head. Said pulses are sent by the rhythmic current pulse action unit which performs the function of a rhythmic irritant to induce sleep in treating different diseases. At the same time, the depth of sleep is regulated by varying the output voltage at the points where the electrodes are applied;

for this purpose, provision is made for said patient protection unit which comes into action when the current characteristics are in excess of preselected valus or in the case of a malfunction of the apparatus.

The rhythmical action unit of said known apparatus comprises a vacuum-tube multivibrator with anode-grid capacitive couplings. This unit ensures a pulse duration of 1.0 to 2 msec in the pulse repetition frequency range of 2 to 25 Hz, and of 0.4 to 1.0 msec in the range of 25 to 130 Hz.

The means for regulating the amplitude of current in the pulses comprises a cascade circuit with a common grid and anode. The maximum output pulse voltage with a load of 5 kohm does not exceed 20 V +25%.

The unit for indicating the mean current intensity value comprises a milliampermeter connected directly to the patient.

The patient protection unit comprises an electromechanical relay which is tripped in the case of increased voltage or a fault in the apparatus.

The above circuit layout of the current pulse rhythmic action unit accounts for the fact that it can only be used for sleep therapy in treating different diseases, without making it possible to rapidly and painlessly attain the second level of the first stage of general electro-anesthesia.

The desien of the known apparatus described hereinabove is such that the current pulse action in sleep therapy can only be intensified by regulating the output voltage.

In order to avoid possible harmful action of current pulses on the organs of vision, the electrodes are attached in the patient's forehead area (the cathode), and in the neck area (the anode), below the mastoids.

It is an object of the present invention to expand the sphere of application and raise the effectiveness of the apparatus for applying current pulses to act upon the central nervous system.

It is another object of the present invention to provide an apparatus for applying current pulses to act upon the central nervous system, which makes it possible to attain the second level of the first stage of general electro-anesthesia in a patient without causing side effects, as well as ensuring selective action upon different organs.

According to the present invention there is provided electro-anaesthesia apparatus, for current pulse action upon the central nervous system of a patient by the application of current pulses to the patient in order to attain the second level of the first stage of general anesthesia, said apparatus including the series combination of rhythmical current pulse generating means, means for adjusting the duration of the individual pulses, means for adjusting the amplitude of the current constituting the pulses, and means for indicating mean current intensity value in the output of the apparatus, patient protection means being provided whereby the application of the current pulses to the patient is automatically discontinued if said current amplitude exceeds a predetermined value, whereby the second level of the first stage of general electro-anesthesia can be attained without causing any sitle effects in the patient.

It is preferred according to the invention, that the proposed apparatus be provided with a selectively operable unit for changing the shape of said current pulses acting upon the central nervous system. When the unit is in use its input would be connected to the output of the means for adjusting the duration of said current pulses, and its output, to the input of the means for adjusting the amplitude of the current constituting said current pulses. The use of such a pulse shape changing unit makes it possible to attain the second level of the first stage of general electro-anesthesia in weak patients and children more conveniently.

It is also preferred that the apparatus according to the invention be provided with a unit for indicating the peak amplitude of the current constituting said current pulses; the input of this unit being connected to an output of said patient protection unit.

It is advisable that the proposed apparatus shall include a buffer unit for permitting separate regulation of the frequency and duration of said current pulses, the input of the buffer unit being connected to the output of the unit for generating rhythmic current pulses and its output, to the input of the unit for adjusting the duration of said current pulses, which makes it possible, in the course of attaining the second level of the first stage of general electro-anesthesia, to effect a selective approach to each patient by varying independently the repetition frequency and duration of the applied pulses.

The proposed apparatus may include a unit for intermittent analgesia in the course of childbirth, its input being connected to the connection between the buffer unit and the unit for adjusting the duration of the current pulses, whereas the output of said intermittent analgesia unit is connected via a switch to the input of the unit for adjusting the amplitude of said current pulses, which makes it possible to ease pain at the start of uterine contractions.

It is desirable that the unit for adjusting the current amplitude of said current pulses shall be constructed as a variable voltage generator, which would make it possible to maintain the second level of the first stage of general electro-anesthesia irrespective of

changes in the functional state of the central nervous system of a patient.

The apparatus of the present invention for current pulse action upon the central nervous system provides for the employment in clinical medicine of general electro-anesthesia equipment to replace psychotherapeutic medicines, tranquilisers, and general anesthetics. Modern anesthesiology teaches that the absence of a pathological reaction to an operational trauma, the regulation of vital systems of the organism during a surgical intervention and after the operation, as well as in the case of a parturient suffering from throbbing pain in the course of delivery, are all ensured by the central nervous system as early as upon the attainment of the second level of general anesthesia and electro-anesthesia (cf. D.Artusio's Classification).

Clinical and experimental studies have revealed that general electro-anesthesia brings about a general physiological reaction on the part of the organism, in which process the dominant role is played by the self-regulation ability of the cerebral cortex.

The preferred form of apparatus embodying the present invention makes it possible to employ, with due regard for the state of the patient and the functional perculiarities of his or her nervous system, the second level of the first stage of general electro-anesthesia, at a value which is optimum for the processes of self-regulation of the cerebrum in accordance with the phase state of the central nervous system.

The foregoing distinctive features of the proposed apparatus substantially expand the sphere of its application and make it possible to regulate the state of the central nervous system in different fields of clinical medicine. The circuit layout of the proposed apparatus makes it possible to employ the second level of the first stage of general electro-anesthesia for treating weak patients and children by changing the shape of current pulses, taking into consideration specific reactions of each patient to changes in the repetition frequency and duration of pulses, and maintain a stable level of the current pulse action irrespective of impedance variations at the points where the electrodes are applied to the patient's head, with different functional states of the cerebral cortex.

The objects and advantages of the present invention will become more apparent from the following detailed description of preferred embodiments thereof taken in conjunction with the accompanying drawings, wherein:

Fig. 1 is a block diagram of an apparatus for producing current pulses action upon the central nervous system, in accordance with the invention;

Fig. 2 shows electrodes for use with apparatus (general view);

Fig. 3 shows an electrode for use with apparatus (side view);

Fig. 4 is a view taken in the direction of arrow A of Fig. 3;

Fig. 5 shows an electrode harness for use with the apparatus (general view);

Fig. 6 shows the same harness on a patient's head;

Fig. 7 is the block diagram of another version of the apparatus according to the invention;

Fig. 8 is a schematic diagram of the apparatus of Figure 1.

The apparatus for current pulse action upon the central nervous system according to the present invention is described with reference to an embodiment thereof intended to act upon the central nervous system for treatment and anesthesia in practical obstetrics.

Referring now to the attached drawings, the proposed apparatus for current pulse action upon the central nervous system comprises, in accordance with the invention, the following series connected units: a unit 1 (Fig. 1) for generating rhythmic current pulses of variable frequency for action upon the central nervous system; a buffer unit 2 for enabling independent regulation of the unit 1 and of a unit 3 which is intended to adjust the duration of the current pulses, the unit 2 being intended, by permitting independent adjustment of the frequency and the duration of the current pulses, to allow an individual approach to every patient upon reaching the second level of the first stage of general electro-anesthesia in the central nervous system of the patient; unit 3 for regulating the duration of said current pulses is intended to produce the second level of the first stage of general electro-anesthesia without causing any side effects in the patient; the apparatus further comprises a unit 4 for changing the shape of said current pulses, said unit 4 being intended to produce the second level of the first stage of general electro-anesthesia in weak patients and children; a unit 5 for adjusting the amplitude of said current pulses; and a unit 6 for indicating the mean current intensity value. The proposed apparatus also includes a patient protection unit 7 to prevent the amplitude of the current constituting said current pulses from exceeding a preselected magnitude; the input of the unit 7 is connected to a second output of the unit 5 for adjusting the amplitude of said current pulses. One otput of said unit 7 is connected to a unit 8 for indicating the peak amplitude value of said current pulses, and its other output is connected to a power supply unit 9 which is connected, in turn, to an input of the unit 1 for

generating rhythmic current pulses action upon the central nervous system, and to a second input of the units 2, 3, 4, and 5.

Connected to an output 10 (shown in Fig. 1 as two terminals) of the unit 6 for indicating the mean current intensity value, with the aid of a plug 13 (Fig. 2), are electrodes in form of a bifurcated cathode 11 (Fig. 2) and a bifurcated anode 12. Each of said electrodes, i.e. each section of the cathode 11 and each section of the anode 12 (Figs. 3 and 4), respectively, comprises a concave disc 14 provided with a conductor 15 (Fig. 3). Said eiectrodes, i.e. the cathode 11 (Fig. 5) and the anode 12, are attached to rubber bands 16 which make up a harness tightly fitting the patient's head 17 (Fig. 6). The cathode 11 is attached in the forehead area of the patient, whereas the anode 12 is attached in the neck area, below the mastoids, in order to produce in the central nervous system said second level of the first stage of general electro-anesthesia.

There may be another embodiment of the proposed apparatus for current pulses action upon the central nervous system to be used for delivery anesthetisation, which apparatus includes a unit 18 (Fig. 7) to produce intermittent analgesia (from throe to throe) in the course of childbirth; this unit 18 is connected to the buffer unit 2. In the latter embodiment of the invention, either the intermittent analgesia unit 18 or the unit 4 for changing the shape of the current pulses is selectively connected to the unit 5 for regulating the amplitude of the current pulses by means of a selector switch 19. This makes it possible to intensify the effect of current pulses in the course of throes by increasing the pulse repetition frequency, without raising the mean current magnitude.

Fig. 8 is a schematic diagram of both the apparatus of Fig. 1 and that of Fig. 7. In both embodiments, the units 1 to 9 are identical.

The unit 1 (Fig. 8) for generating rhythmic current pulses preferably comprises a multivibrator with collector-base capacitive couplings, consisting of transistors 20 and 21, resistors 22, 23, 24, 25, 26, 27 and 28, an adjustable resistor 29, capacitors 30 and 31, and diodes 32 and 33.

The adjustable resistor 29 is used to regulate the pulse repetition frequency within a preselected range. At the of junction of the resistors 27 and 28, an output of the unit 1 is connected to the base of a transistor 34 of the buffer unit 2 for enabling independent regulation of the units 1 and 3.

The buffer unit 2 is constructed as a differentiating circuit comprising the transistor 34, resistors 35 and 36, and a capacitor 37.

The output of the unit 2, which is at the collector of the transistor 34, is coupled via a diode 38, in the unit 3 for regulating the current pulse duration, to the base of a transistor 39 of that unit.

The circuitry of the unit 3 is that of a monostable multivibrator with collector-base capacitive couplings, and comprises transistors 39 and 40, resistors 41, 42, 43, 44 and 45, an adjustable resistor 46, capacitors 47 and 48, and diodes 38 and 49. The resistor 46 serves to regulate the current pulse duration within preselected limits.

The output of the unit 3, which is at the collector of the transistor 40, is connected to the base of a transistor 50 of the unit 4 for changing the shape of the current pulses.

The unit 4 comprises a first pulse former yielding square pulses and a second pulse former yielding pulses with an exponential trailing edge. The first pulse former consists of a differential amplifier comprising transistors 50 and 51, resistors 52, 53, 54, 55 and 56, an adjustable resistor 57, and capacitors 58 and 59. The second pulse former comprises a common-collector transistor 60, resistors 61 and 62, and capacitors 63 and 64. Pulse shape selection is done with the aid of a switch 65.

The adjustable resistor 57 serves to maintain a constant voltage amplitude irrespective of a change in the pulse shape. The output of the unit 4 is coupled via the contacts of the switch 65 to the base of a transistor 66 of the unit 5 for regulating the current amplitude in the output pulses.

The unit 5 for regulating the current amplitude of the pulses is constructed as a voltage generator, which makes it possible to maintain, irrespective of the function state of the central nervous system of the patient, the second level of the first stage of general electro-anesthesia. This voltage generator comprises the transistor 66 with a common emitter, a resistor 67, an adjustable resistor 68, a transistor 69 provided with a common collector, a resistor 70, an adjustable resistor 71, capacitors 72 and 73, transistors 74 and 75, and resistors 76, 77 and 78.

The output of the unit 5, which is taken from the emitter of the transistor 75, is connected to an input of the unit 6 for indicating the mean current intensity value.

The unit 6 comprises a measuring instrument 79, resistors 80 and 81, and a switch 82 which serves to calibrate the measuring instrument. Connected to the output 10 of said unit 6 with the aid of the plug 13 (Fig. 2) are the electrodes, i.e. the anode 12 (Fig. 8) and the cathode 11. The latter is grounded.

The patient protection unit 7 (Fig. 8) comprises a relay 83, resistors 84, and 85 and 86, a capacitor 87, and a switch 88 for setting the relay 83 in the initial position. The patient protection unit 7 is connected to the collector circuit of the transistors 74

and 75 of the unit 5. The output of the unit 7 is connected to the input of the unit 8 for indicating the peak current pulse amplitude intensity value.

The circuitry of the unit 8 is that of a peak voltage detector. The unit 8 comprises a resistor 89, a diode 90, resistors 91 and 92, a capacitor 93, a measuring instrument 94, and a switch 95. The switch 95 serves for resetting the pointer of the measuring instrument 94.

The power supply unit 9 comprises a voltage changer, a rectifier and a voltage stabilizer. The voltage changer comprises transistors 96 and 97, resistors 98, 99 and 100, a capacitor 101, and a transformer 102. Said rectifier comprises a diode 103, a resistor 104, and a capacitor 105. The voltage stabilizer comprises a silicon Zener diode 106, a resistor 107, and capacitors 108, 109 and 110.

A switch 111 is intended to apply the supply voltage to the voltage stabilizer and the voltage changer. A contact 112 of the relay 83 serves to cut off the supply voltage generated by a power source 113 from the voltage changer and the voltage stabilizer if the current amplitude is in excess of preselected values. The presence of a high voltage supply from the voltage changer is indicated by the glow of a neon lamp 114 which is connected to a resistor 115.

According to the second embodiment of the invention, the unit 18 (Fig. 7) for intermittent analgesia (from throe to throe) in the course of delivery preferably comprises an integrated microcircuit such as a J—K flip-flop.

The apparatus of Fig. 1 for current pulse action upon the central nervous system operates as follows.

The harness made up of the rubber bands 16 is fitted over the patient's head 17 (Fig. 6). The cathode 11 is attached in the forehead area of the patient, and the anode 12, in the neck area, below the mastoids, in order to produce the second level of the first stage of general electro-anesthesia.

A series of square pulses is generated at the output of the unit 1 (Fig. 8) for rhythmic current pulse action upon the central nervous system. The repetition frequency of said pulses is varied between 100 Hz and 7 kHz with the aid of the adjustable resistor 29. From the output of the unit 1 said series of pulses is applied to the unit 2 for securing independent regulation of the units 1 and 3. At the output of the unit 2 is formed a series of pulses, each pulse having a duration of 0.05 msec and a repetition frequency corresponding to that of pulses sent from the unit 1. The unit 2 enables independent adjustment of the frequency and of the duration of the output pulses ant thus provides for a selective approach to every patient upon producing in the central nervous system the second level of the first stage of general electro-anesthesia.

From the output of the unit 2 the series of pulses is applied via the diode 38 to the input of the unit 3 for regulating the pulse duration. The adjustable resistor 46 regulates the pulse duration, which makes it possible to produce in the central nervous system of the patient the second level of the first stage of general electro-anesthesia without causing any side effects. The pulse signal with a desired duration is applied from the output of the unit 3 to the input of the unit 4 for changing the pulse shape, where the pulse shape is selected with the aid of a switch 65. The latter makes it possible to produce the second level of the first stage of general electro-anesthesia in weak patients and children.

From the output of the unit 4, the series of pulses is applied to the pulse current amplitude regulation unit 5 which maintains constant the second level of the first stage of general electro-anesthesia irrespective of changes in the functional state of the central nervous system, and which also makes it possible to regulate the pulse current amplitude with the aid of the adjustable resistor 68.

From the output of the unit 5, the signal is applied to the measuring instrument 79 of the unit 6 for indicating the mean current intensity value, which instrument is used to control the level of general electro-anesthesia. From the output of the unit 6 and via the switch 82, the signal is applied to the anode 12 attached to the patient's head 17 in the neck area, below the mastoids.

The patient protection unit 7, which is connected to the collector circuit of the transistor 75 of the unit 5, disconnects the power unit 9 from the power source 113 with the aid of the contact 112 of the relay 83, which ensures absolute safety of the patient and stops the sending of a current pulses to the anode 12 if the current amplitude is in excess of a preselected value.

The output of the unit 7 is connected to the unit 8 for indicating the peak current value, which unit 8 measures the peak amplitude of the current. In conjunction with the operation of the unit 6, this makes it possible to check the anesthesia level upon attaining the second level of the first stage of general electro-anesthesia.

The operating principle of the apparatus of Fig. 7 is similar to that of the apparatus of Fig. 1.

The difference between the two embodiments lies in the fact that a series of pulses from the output of the unit 2, is applied to the input of the intermittent analgesia unit 18 (Fig. 7), which series has

a pulse repetition frequency corresponding to that set in the unit 1. At the output of the unit 18 a series of square pulses is formed with a mark/space ratio equal to 2:1. The switch 19 is used to bring into play the unit 18 when there is the necessity to perform anesthesia with the start of uterine action.

The sequence of operations necessary to produce the second level of the first stage of general electro-anesthesia with the aid of the apparatus for current pulses action upon the control nervous system of Fig. 1 is as follows. The electrodes are applied onto the patient's head, and the pulse repetition frequency is set in the unit 1 to between 100 Hz and 7 kHz. With the aid of the unit 2 for securing independent regulation of the units 1 and 3, the pulse repetition frequency is matched with the pulse duration, which ensures a selective approach to every patient. The unit 3 regulates the current pulse action to achieve the second level of the first stage of general electro-anesthesia without causing side effects in the patient. The unit 4 also enables the rectangular shape of the current pulses to be changed to a triangular form, which makes it possible to attain the second level of the first stage of general electro-anesthesia in weak patients and children. The unit 5, which is constructed as a voltage generator, serves to maintain stable the second level of the first stage of general electro-anesthesia irrespective of changes in the functional state of the control nervous system. That is followed by selecting the current amplitude of the pulses.

The above sequence of operations is performed to attain the second level of the first stage of general electro-anesthesia with the aid of the apparatus of Fig. 7 employed for delivery anesthetizing.

In each particular case, the absolute values of different pulse action parameters may be different. Clinical symptoms are then checked, which characterize the optimum self-regulation level in the central nervous system and the establishment of a stable vegetative equilbrium (stabilized pulse, breathing and blood pressure).

At present, substantial clinical experience has been accumulated (some 600 observations) in employing the second level of the first stage of general electro-anesthesia in different areas of obstetrics and gynecology. In order to rule out the effects of pharmaceuticals upon the organism of an expectant mother and fetus in cases of functional neuroses and emotional stresses, the expectant mother is prepared for delivery by being subjected to current pulse action upon the central nervous system in clinical conditions. The category of females for whom such preparation is indicated includes expectant mothers who have previously suffered a birth failure, those suffering from gynecological and somatic diseases, and those passing through an early stage of late toxemia of pregnancy.

As far as hospitalizied patients are concerned, the second level of the first stage of general electro-anesthesia is employed for treating light and moderate nephropathy and for the prevention of severe nephropathy.

The second level of the first stage of general electro-anesthesia is produced in expectant mothers two weeks before the delivery to prevent disorders in uterine action. A total of 600 cases was observed, with the treatment being 85 to 90 percent effective.

Current pulse action treatment is employed in the course of delivery to replace pharmaceuticals which are normally used to give a respite to the parturient or prevent a painful delivery.

In cases of uterine inertia during the latent and active phases of labor, current pulses are successfully employed to regulate uterine activity (200 cases). This has been corroborated by statistical processing of information on contractions of the body and the lower part of the uterus (hysterography).

Research in the field of maieutics was accompanied by studies of the biological activity of the cerebrum and the cardiovascular system of the mother and the fetus.

In cases of late toxemia of pregnancy, current pulse action normalizses the electric activity of the cerebrum and improves the cerebral circulation (rhoencephalography).

Pulse currents improve cardiac action of the fetus through facilitating the circulation in the uterus and dilating the vessels (electrohonocardiography of the fetus, rheography of the uterus).

As an intensive therapy means, the second level of the first stage of general electro-anesthesia is employed during the postoperative period to regulate vital functions of the organism (narcosis) and replace preparations of the morphine group (100 cases).

Contraindications to current pulse treatment are severe somatic disorders requiring a special course of treatment, organic disorders of the nervous system, the impossibility of spontaneous delivery, placenta praevia, ablatio placentae, the danger of hystorrhoxis, precclampsia, eclampsia, coma, and mental aberrations.

Current pulse treatment must not be combined with atropine, tranquilizers, and non-inhalation anesthesia. The above combinations may lead to uncontrolled

anesthesia which may reach the surgical level.

It is recommended that current pulse action should go along with pypolphen, petidine (one time only), and nitrous oxide with oxygen.

The apparatus of the present invention can be mass-produced with the aid of micromodules and printed circuits.

The apparatus described above is absolutely safe in operation, autonomous, and portable, which factors promise its wide application in all fields of medicine. The apparatus of the invention may find extensive application in a portable version to be used in rural areas or in cases when a parturient is delivered of a child at home. The apparatus may be handled by medium-level medical personnel, provided that the general supervision is done by a doctor. The apparatus of the present invention may be used in field conditions to combat shock before qualified medical aid is available. In cases of oxygen deficiency (submarines, underground installations, high altitudes) the apparatus of the present invention makes it possible to treat functional disorders of the central nervous system without resorting to pharmaceuticals whose removal from the organism is much slower than normal in the above-mentioned conditions.

WHAT WE CLAIM IS:—

1. Electro-anaesthesia apparatus, for current pulse action upon the central nervous system of a patient by the application of current pulses to the patient in order to attain the second level of the first stage of general anesthesia, said apparatus including the series combination of rhythmical current pulse generating means, means for adjusting the duration of the individual pulses, means for adjusting the amplitude of the current constituting the pulses, and means for indicating mean current intensity value in the output of the apparatus, patient protection means being provided whereby the application of the current pulses to the patient is automatically discontinued if said current amplitude exceeds a predetermined value, whereby the second level of the first stage of general electro-anesthesia can be attained without causing any side effects in the patient.

2. Apparatus as claimed in claim 1 and including means for modifying the shape of the individual current pulses applied to the patient, said modifying means having its input connected to the output of the means for adjusting the duration of the pulses and its output connected to the input of the means for adjusting the amplitude of the pulses, which makes it possible to attain the second level of the first stage of general electro-anesthesia in weak patients and children.

3. Apparatus in accordance with claim 1 or claim 2 and including means for indicating the peak amplitude of the current forming the output pulses of the apparatus, said indicating means having its input connected to an output of the patient protection means, which latter follows the means for adjusting the amplitude of the current pulses.

4. Apparatus in accordance with claim 1, 2 or 3 and including buffer means permitting independent adjustment of the output frequency of the means for generating rhythmical current pulses and of the means for adjusting the duration of the current pulses, the input of said buffer means being connected to the output of the means ofr generating rhythmical current pulses and its output being connected to the input of the unit for adjusting the duration of the current pulses.

5. Apparatus in accordance with claims 2 and 4 and including means for providing pulses for use in intermittent analgesia in the course of childbirth, said last-mentioned means having its input connected to the output of the buffer means and being arranged to provide rectangular output pulses of 2:1 mark/space ratio, the output of said last-mentioned means being arranged to be selectively connected via a switch to the means for adjusting the amplitude of the current pulses.

6. Apparatus in accordance with any one of claims 1 to 5 wherein the means for adjusting the amplitude of the current pulses is constructed as a voltage output stage.

7. An apparatus in accordance with any one of the preceding claims, substantially as hereinbefore described with reference to the accompanying drawings.

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Sheet 1

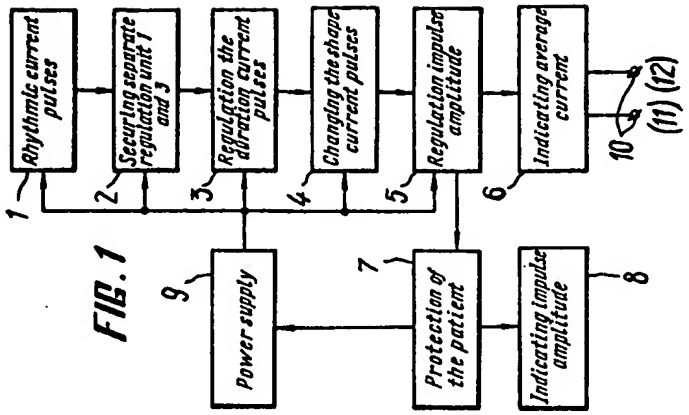

FIG. 1

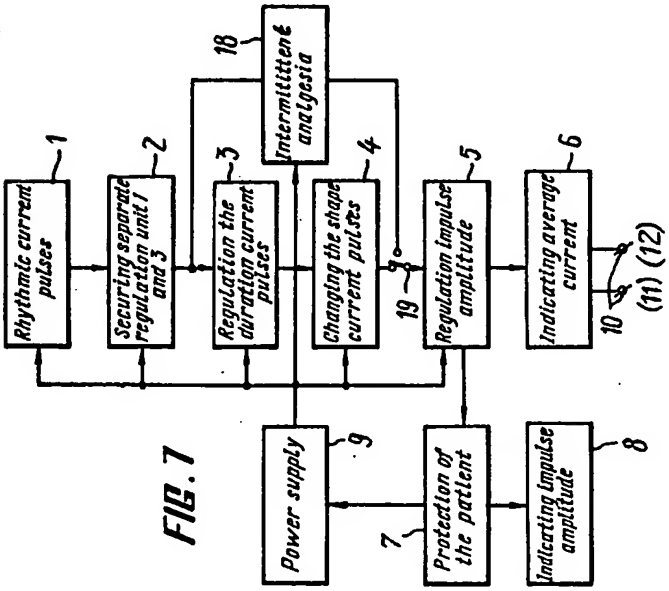

FIG. 7

1535413 COMPLETE SPECIFICATION
3 SHEETS *This drawing is a reproduction of the Original on a reduced scale*
Sheet 2

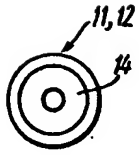

FIG. 4

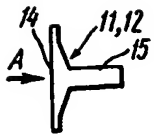

FIG. 3

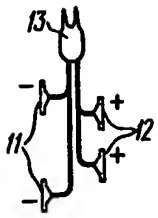

FIG. 2

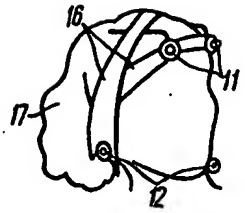

FIG. 6

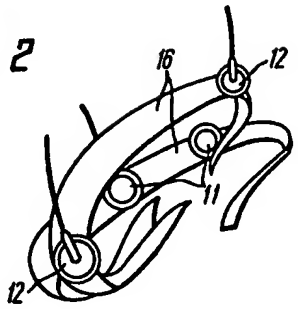

FIG. 5

1535413 COMPLETE SPECIFICATION

3 SHEETS *This drawing is a reproduction of the Original on a reduced scale*

Sheet 3

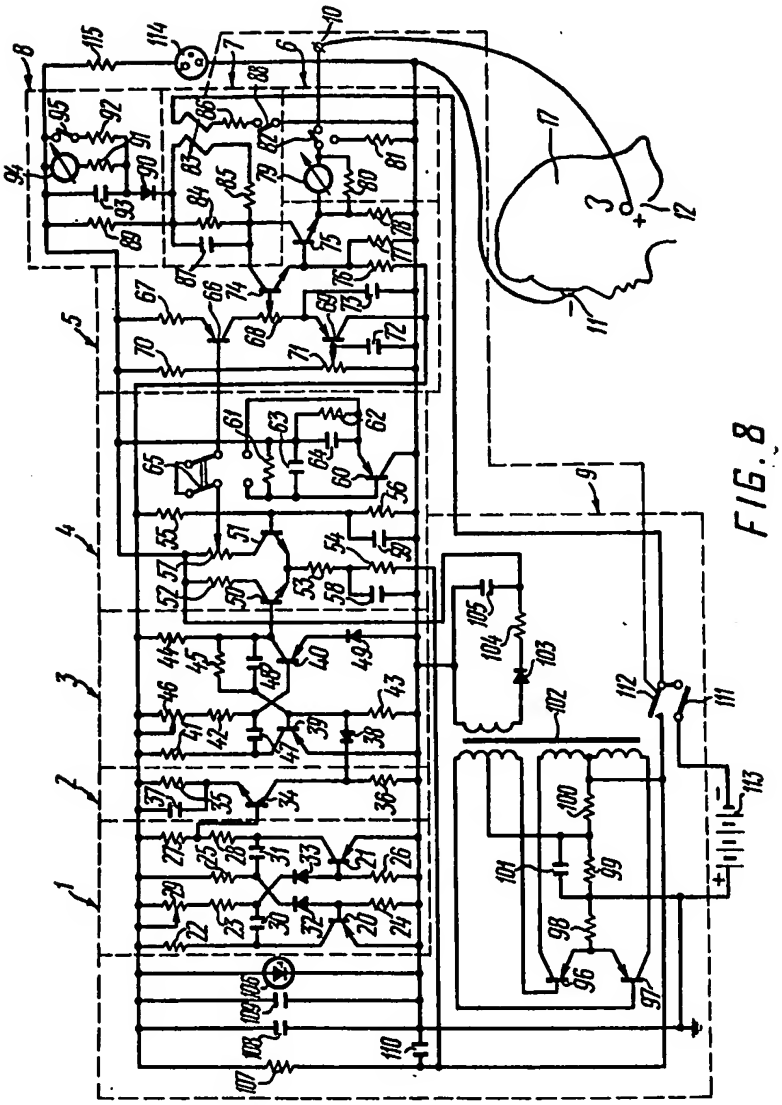

FIG. 8